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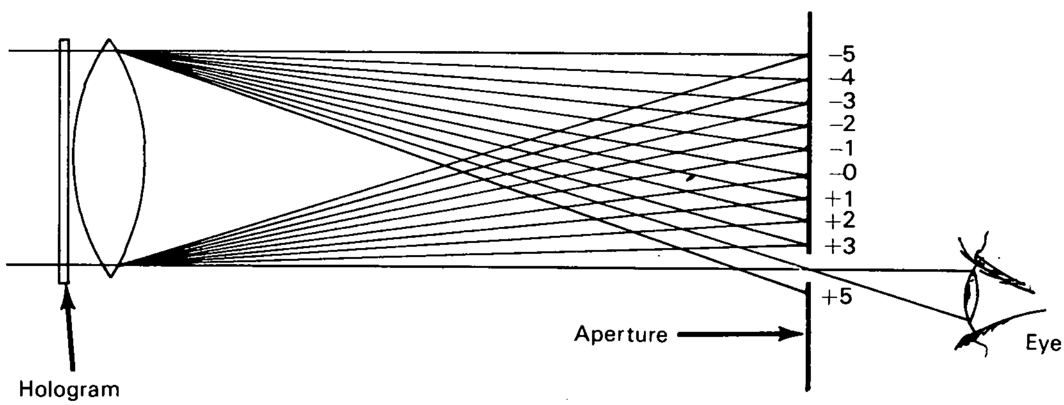
NASA TECH BRIEF

Fine-Line Sensitivity for Holographic Interferograms



Holography — the technique of lensless interferometry — has proven to be an extremely useful tool in an expanding number of scientific and engineering disciplines. And, as in most technologies, there are continual efforts to improve the sensitivity of the technique. It is intuitively apparent that since holography is a light interference phenomenon, greater sensitivity can be obtained by enhancing the higher-order structure in the interferogram.

By using the light diffracted into higher orders than the first, the phase sensitivity of holographic interferograms can be increased over the first order sensitivity by a factor equal to the order number used. In other words, if the fourth order is used, the sensitivity is increased by a factor of four.

The experimental arrangement for the formation of the holograms consists of two beams from the same laser source impinging at a small angle on the hologram so that moderately coarse fringes are produced. The Michelson arrangement is convenient for this purpose since it permits the subject to be placed easily in one of the beams while avoiding long paths between subject and hologram. Interferometric accuracy is not required for the components nor the adjustment. The general procedure for constructing the holographic interferogram consists of the following operations: step one — make a heavily exposed hologram of the empty scene; step two — on a second photographic plate, make a heavily exposed hologram with the phase subject in place in one of the beams; step three — on a third photographic plate, make a double-exposed contact print of the holograms made in steps one and two, one exposure from the hologram of step one and the other exposure from the hologram of step two; step four — reconstruct the contact print of step three with a laser and view the light diffracted into the n^{th} order. A lens and aperture near the focal point are useful in isolating the light of a particular order, as shown in the figure. The intensity variations viewed by the observer correspond to the intensity variations of conventional interferograms of the subject except that the phase sensitivity is now n times as great. A number of experimental tests of the two exposure double-contact print process have been carried out with a

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He-Ne gas laser. The best performance achieved so far is a factor of four, obtained by readout in the fourth order. Since each fringe in the interferogram results from an average taken over a great many fringes on the contact print, the lines are straighter and more uniform. Also, the new technique makes small phase shifts evident by visual inspection.

Further enhancement can be obtained by displacing the original holograms during the contact printing step. For instance, if each original exposure is exposed n times during the contact printing step, with a displacement of one n^{th} the fringe spacing between each exposure, the resulting contact print will diffract n-squared times as much light as the singly exposed contact print. The one limitation is that the thickness of the line must not cause an overlap of lines during the multiple printing.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
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National Aeronautics
and Space Administration
Washington, D.C. 20546
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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